***RadSCape**: radiative transfer simulation and validation of the dynamic structural and spectral properties of the vegetation of the Cape

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DIRSIG Simulation Team:

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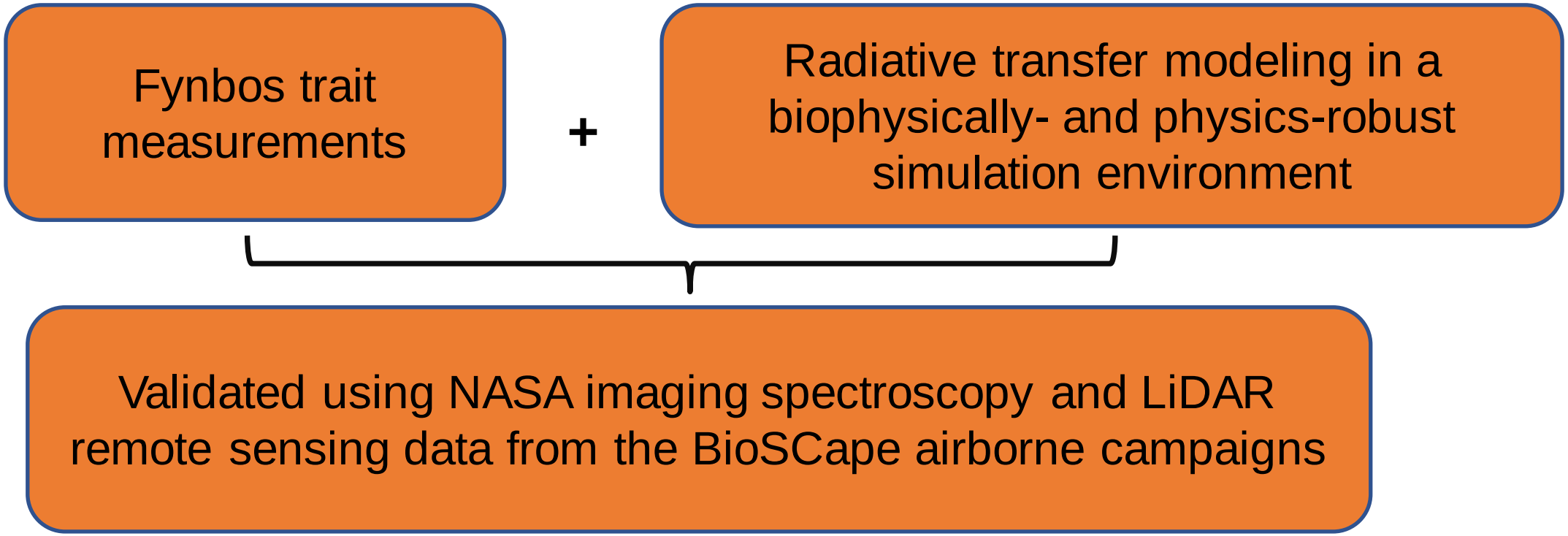
**Assumption: Cape region's ecological importance has been explained*

What We Proposed

- Improve remote measurement & monitoring via a combination of



- To improve our understanding of light interactions within the context of fynbos biophysical traits, at different spatial scales, spectral resolutions, and other system parameters
- A mechanistic linking of structure/spectra-to-traits & assess approaches to track biodiversity as a function of post-fire recovery time

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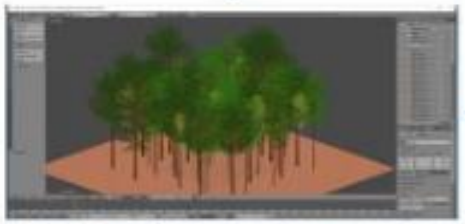
The Simulation Backbone - DIRSIG

ii) Spectral & emissive properties

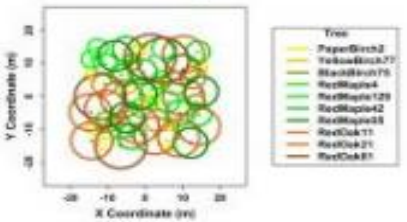
iv) Simulation of a suite of modalities

Scene Geometric Properties

OnyxTree

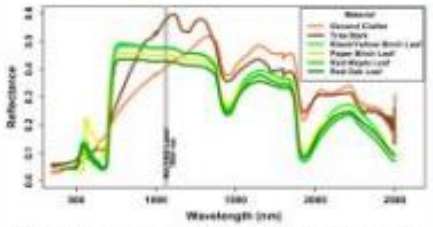


Blender



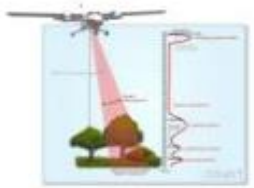
Field Measured Vegetation Structure

Scene Optical Properties



Field Spectra or PROSPECT with Field Sampled Foliar Properties

DIRSIG engine

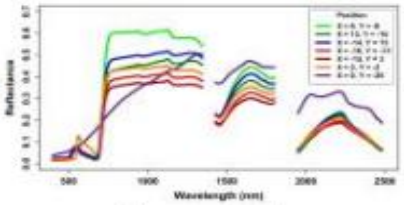


Instrument/Collection Parameters

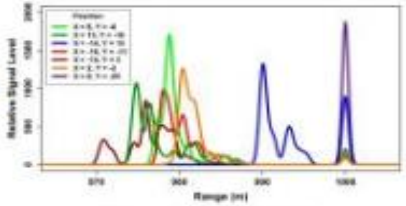
Instrument Properties

Remote Sensing Simulated Outputs

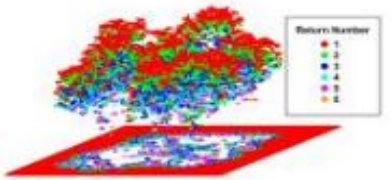
Multispectral Camera



Hyperspectral



Waveform LiDAR



Discrete Return LiDAR

i) Develop a geometrically accurate scene

iii) Collection parameters

Field Sampling

Grootbos Nature Reserve

- Capture variability in fynbos species composition/structure for virtual scene development
- Capture level and status of post-fire recovery status, based on fire history

Field data (October 2022)

- Five plots per study area, with most plots @ 50 m^2, 5m x 5m/ 5m x 10 m releves
- Spectral measurements of leaf reflectance (ASD)
- Terrestrial laser scanning (TLS) data via a UMass Boston/RIT-developed TLS and iPad scanning

Grootbos Nature Reserve

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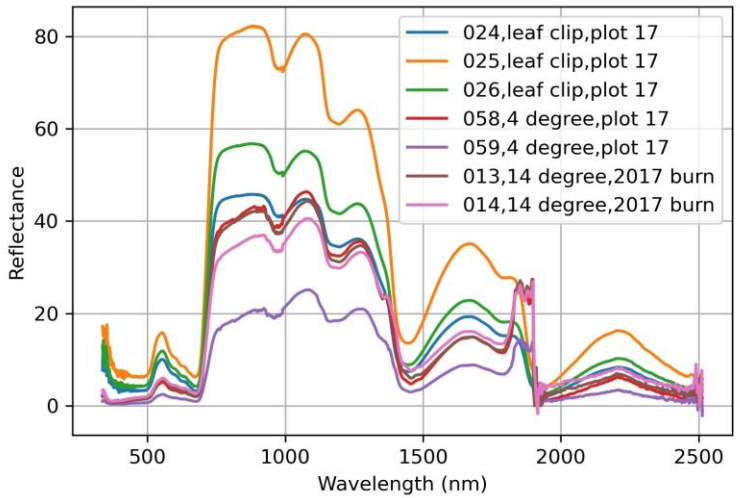
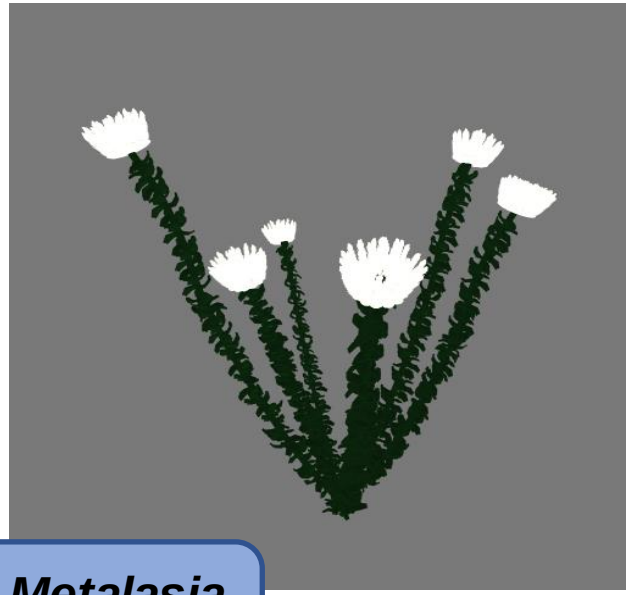
Field Campaign *(October 2022)*



Anthospermum aethiopicum

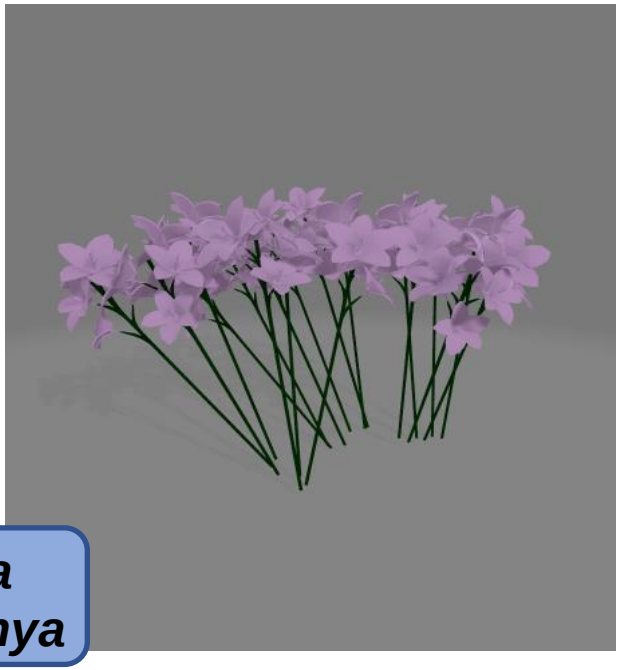
iPad *.ply scan of *Cliffortia ilicifolia*

DIRSIG Virtual Scene Development



Metalasia muricata

Passerina corymbosa



Indigofera brachystachya

Euclea racemosa

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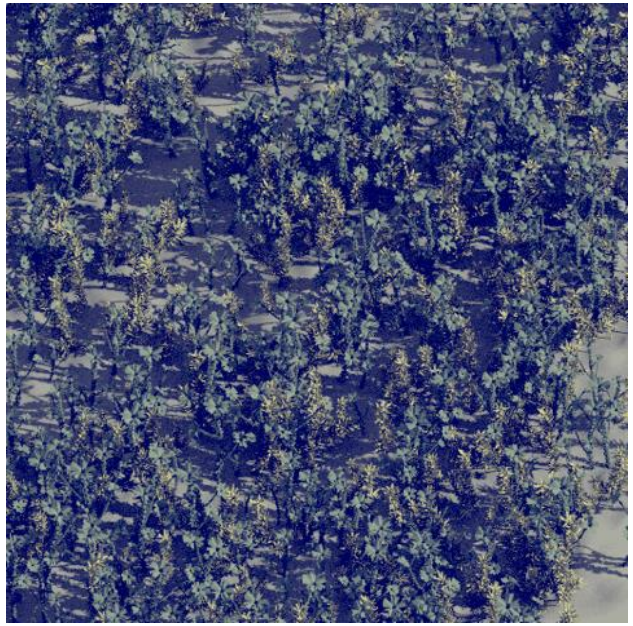
DIRSIG Virtual Scene Render - early stages

Adding fynbos structure to a Lambertian background

…densifying that structure to represent different mixtures

Different species structures

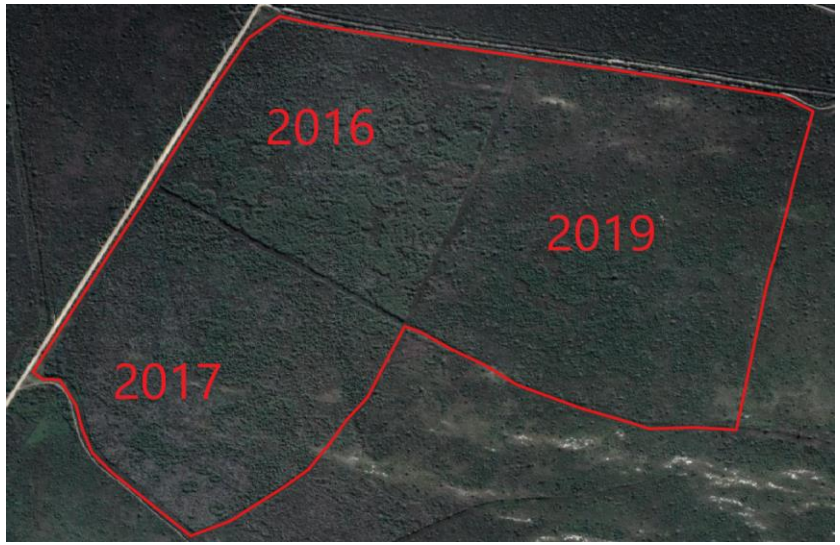
An example of a 2019 burn plot, with initial regrowth shown (four species included)



Validation – in progress

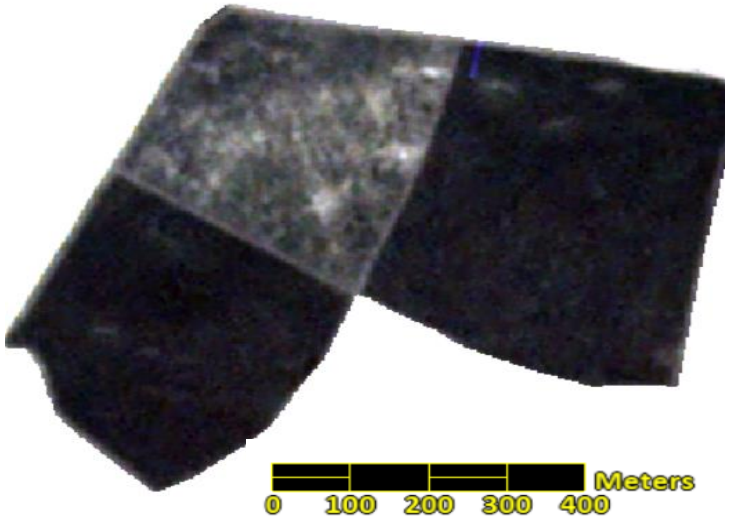
Validation using

- drone-based structure-from-motion and multispectral imagery
- NASA BioSCape airborne campaign data
- commercial satellite imagery



Grootbos plots
Planet data (3m resolution)

Before - 2016



Current

Final Thoughts

- Our broad project goals are to i) assess ideal system parameters for spectral/structural trait remote sensing of the complex fynbos biome and ii) develop algorithms for tracking post-fire recovery and biodiversity

- This can be approached in a variety of ways, e.g., unmixing algorithms (linear vs. non-linear), machine learning, etc.

- Also using a fusion approach (imaging spectroscopy & LiDAR) for trait assessment as function of post-fire recovery stage

- We plan to do so using a first-principles, physics-based simulation tool, validated using real NASA and other data sources

Next steps & risks

- We need to ensure that virtual scenes are close approximations of the real environment

- We will rely heavily on BioSCape team collaborations for access to trait surveys and spectral data to parameterize the virtual scenes

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